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Is the sky or the earth the limit? Risk, uncertainty and nature

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ABSTRACT

Dealing with uncertainty has become a matter of great concern for policy makers and scientific research in a world facing global, epochal and complex changes. But in essence, you cannot entirely predict the future. This article aims at conceptualizing the limits to anticipate the future – or what is often referred as the substitution of risk for uncertainty. In contrast to most theories examining risk and uncertainty, we start from the assumption that there are limits in the substitution of risk for uncertainty and that distinguishing between ontological and epistemic levels of analysis helps clarify such limits. The paper makes two arguments: first, most approaches see no ontological and/or epistemic limit in the substitution of risk for uncertainty; second, the pluralization of science is the only way to cope with limits in substituting risk for uncertainty. This second argument draws on the assumption that accounting for the uncertainty of the future depends on knowledge production processes able to overcome disciplinary boundaries and better include lay and expert knowledge. In times of great concerns regarding mitigation and adaptation to the ecological crisis, we illustrate our arguments with insights from global environmental governance.

KEYWORDS

Environment; expertise; global governance; measurement; ontology; pluralization of science; risk management; uncertainty

Introduction

'The scariest part is that we do not know what is going to happen. Everything is possible (…) Our future is totally unknown. I feel like I do not have control over it' (Massiot, 2019. 'Libération', our translation). Such emphasis made by the climate activist Greta Thunberg in a French newspaper reflects the larger issue of how we anticipate the full range of uncertainties arising from the ecological crisis, including biodiversity loss, ecosystem services degradation, local and global tipping points, and climate change. The same concern bears upon finance, security, or health issues as illustrated by the dramatic experience of the Covid-19 pandemic. To this end, large tracks of scientists and organizations have developed complex knowledge infrastructures to calculate uncertainty and reduce it into a risk. The concept of risk indeed describes a phenomenon that can be objectified, anticipated, and

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ultimately managed with numbers, in which future outcomes have known probabilities. This contrasts starkly with uncertainty: the concept involves a situation in which information, knowledge, and calculation techniques are considered as insufficient to assess or measure the future. While the substitution of risk for uncertainty thus appears as highly valuable, a question remains: are there limits in substituting risk for uncertainty and, if so, how to cope with them?

In the contemporary world, the prospect of reducing uncertainty and converting it into an objectified and quantified risk involves in one way or another the ability of states, markets and a flurry of non-state actors to shape the relation between economic and political spheres across borders. This is for instance how Blyth (2002) engages constructivist debates by emphasizing how agents' behavior derives from the uncertainty shaping their ability to identify their interest. Ultimately, the conceptualization of risk and uncertainty determines how scholarship in international political economy is likely or not to anticipate future events (Blyth & Matthijs, 2017). The few studies in international political economy specifically focused on the relationship between risk and uncertainty take a critical perspective on how the world is made 'more certain, controllable, and governable' (Deuchars, 2004, p. 2), as states, corporations and individuals all build on a common language of quantifiable risk in the context of globalization (Dannreuther & Lekhi, 2000). They focus on how the substitution of risk for uncertainty reflects a 'strategisation of time' (Lobo-Guerrero, 2014), depends on social conventions (Katzenstein & Nelson, 2013), and invents new institutions to 'absorb uncertainty into manageable risk' (Kessler, 2010, p. 119). With few exceptions, these studies see no limit in the conversion of uncertainty into risk. The same holds true for cognate fields of studies. In economics, a much greater number of prominent studies have examined the relation between markets, risk and uncertainty (Akerlof, 1970; Arrow, 1963; Friedman & Savage, 1948; Gollier, 2018). While varying in many respects, they all see the future as subject to a well-defined and objectified analysis (Reddy, 1996, p. 230). They thus take their distance from the divide between risk and uncertainty that Keynes (1921) and Knight (1921) pioneered a century ago. For their part, studies in economic sociology precisely take as object of their critical enquiry such limitless practices of turning anything at hand into a risk likely to be accounted in market terms (Fourcade & Healy, 2013; MacKenzie, 2006; Muniesa et al., 2007).

In contrast, this paper starts from the assumption that there are limits in the substitution of risk for uncertainty. In this context, distinguishing between ontological and epistemic levels of analysis helps clarify such limits. This distinction has already been made in one way or another in economic literature, in particular in post-Keynesian economics (Davidson, 1996) and in economics of conventions (Orléan, 1987). Moreover, as Dequech (2004, p. 375) points out, there is 'strong entwinement of ontology and epistemology' in this debate, as social reality and the production of knowledge remains entangled from a post-positivist perspective. Against this background, this paper sets out to analyze the limits in which risk can be substituted for uncertainty. The paper makes two arguments: first, most theories examining risk and uncertainty see no ontological and/or epistemic limit in the substitution of risk for uncertainty; second, the pluralization of science is the only way to cope with limits in substituting risk for uncertainty. The first argument is based on a critique of a large corpus of theories accounting for the future as a relation between risk and uncertainty.[1] The second argument draws on the assumption

that accounting for the future depends on knowledge production processes able to overcome disciplinary boundaries, and to better include lay and expert knowledge. In our view, international political economy literature would be well informed to consider such limits when analyzing the relation and substitution between risk and uncertainty. In times of great concerns regarding mitigation and adaptation to the ecological crisis, we illustrate our arguments with insights from global environmental governance and opposing responses to the relations between the economy, nature and society.

This article first provides some background on the case we draw from to illustrate our argument before turning on the theoretical framework used for our analysis. The three following sections analyze theories on the relation between risk, uncertainty and the future in mainstream economics, heterodox international political economy and sociology, and evolutionary political economy; they set to probe our first argument regarding the absence of ontological and/or epistemic limit in the substitution of risk for uncertainty. The last section focuses on our second argument and explains how the pluralization of science provides a promising avenue for understanding intrinsic limits in the substitution of risk for uncertainty. We conclude by coming back on our arguments and by suggesting further avenues for research.

Risk, uncertainty and the ecological crisis: on the importance of limits

While nature has long been viewed as the 'ahistorical, stable and fixed stage of the changes triggered by humans and societies' (Granjou, 2016, p. xi), the abrupt, complex and nonlinear changes related to the ecological crisis have shown that this is not the case. In 1982, the Organisation for Economic Co-operation and Development published a report about economic and ecological interdependence that already identified uncertainty as the major challenge of an ever more tangible ecological crisis: 'uncertainty prevents us from understanding the possible evolution of natural phenomena' (OCDE., 1982, p. 9, our translation). Since the ecological crisis is no longer a future possibility but a present reality, discourses have now changed and often use the concept of risk instead of uncertainty. This understanding of risk is basically the one used in the Global Risk Report published each year by the World Economic Forum (2020, p. 88). The insurance industry is another case in point. While insurers and actuary scientists are dealing with the impacts of the ecological crisis,[2] their raison d'être is to transform these uncertainties into fungible risks on which standardized economic transactions and commodified exchanges can take place (Graz, 2019, pp. 117–122; Lobo-Guerrero, 2011, p. 11). Beyond the insurance industry, various risk and sustainable management techniques support the ability of capitalism to face the ecological crisis (Levy et al., 2016; Ponte, 2019; Sharma & Soederberg, 2020).

These interrelations between quantitative risk governance and uncertainties generated by the ecological crisis are far from new. The report *Limits to Growth* was already an attempt to map, calculate, and model the biophysical 'future course of human society' (Meadows, 1972, p. 17). Similar anticipatory models drive the two largest global assessments ever made on the consequences of ecosystem change for human well-being: *The Millennium Ecosystem Assessment* (2005) and the reports of the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (see for instance its latest global report: IPBES, 2019). They both put great

emphasis on economic methods and quantitative reasoning in the range of anticipatory techniques and responses worked out to face the ecological crisis. So-called 'ecological risks' are illustrated by quantitative 'biophysical thresholds' or 'planetary boundaries' that could be exceeded depending on certain anticipatory scenarios and probabilities. These boundaries are defined by Rockström et al. (2009) as 'safe operating space for humanity with respect to the Earth system' (p. 472), so that thresholds can be clearly defined with the help of numbers.

A good case in point is the recent modelling of the future of the Greenland ice sheet through big data analysis made by the National Aeronautics and Space Administration (NASA). By putting 'the best physics possible in there' and building on 'datasets that help drive models', NASA scientists have transformed the uncertainty of 'how greenhouse gases may impact Greenland and us in the future' into a measurable and therefore manageable risk (NASA Goddard Space Flight Center, 2019). Scientists underline the yet unmanageable uncertainties arising from 'cascading dominos of feedback loops', such as 'the thawing and decomposition of carbon stored in permafrost [that] generates greenhouse gases' (Vonk & Gustafsson, 2013, p. 675). Yet, they still have good hope in our future technological capacities and intellectual performances to transform such phenomenon into a set of measurable risks. As we will see below, such a belief in the progress of our knowledge and techniques is largely counterproductive and prevents a real understanding and acceptance of a situation marked by unknowable uncertainties – and thus the ability to provide credible responses. It also highlights much confusion between risk and uncertainty – two notions that remain too often ill-defined. In a world facing global, epochal and complex changes, this prompts us to conceptualize the distinction between risk and uncertainty, the limits in the substitution of one by another, and the nature of such limits.

Drawing on Dequech (1999) and Reddy (1996), we understand uncertainty as a situation in which knowledge and information about a phenomenon is insufficient to allow our individual and collective cognitive capacities as well as our present calculation techniques to form any judgement or measure about the future. In this respect, a state of uncertainty can apply to our future technical and intellectual capacities to anticipate these uncertainties, so that we cannot simply rely on the hope of future progress. In contrast, risk refers to a phenomenon that can be objectified, anticipated, and ultimately managed with numbers, in which future outcomes have known probabilities. Against this background, the method used by policy makers and researchers for anticipating the future by substituting risk for uncertainty is a two-step process. First, it requires a classification of objects according to the available information and knowledge. Second, the calculation of probabilities. As Desrosières (2002) points out, 'these two processes – defining classes of equivalences and encoding – constitute the essential stages of statistical work' (p. 8). In other words, unknown events are first included into a frame of reference, and then probabilities and values related to their outcome are computed.

While some theories examining risk and uncertainty recognize some limits in substituting risk for uncertainty, only few distinguish between their ontological and epistemic levels of analysis. As seen in the introduction, such distinction echoes previous analyses in Post-Keynesian economics (Davidson, 1996; Dequech, 2004) and economics of conventions (Orléan, 1987). We refer here to the epistemic dimension to explore the production of knowledge that is used to anticipate the

future. An epistemic limit thus relates to an individual or collective inability to produce the required knowledge to turn an uncertain future phenomenon into a manageable risk. This is what Dequech (2004) appraises as the limits of 'people's mental abilities' to anticipate the future (p. 368). At the ontological level of analysis, we focus on whether any kind of uncertain phenomenon that could occur in the future world can be assessed in such a way as to make it less 'truly uncertain'. As Dequech (2004) points out, uncertainty is not only a matter of knowledge, but can also be 'caused by, or described as, some properties of reality' (p. 368). In our view, an ontological limit of substituting risk for uncertainty would exist if a distinct class of objects are defined as unfit for quantifiable probabilities and expectations about the future. In such cases, the inability to turn uncertainty into a well-defined set of instances (or into a set of risks) is inferred from the nature of such and such real phenomena, rather than from the development of the apposite knowledge. It would be for instance the characteristics of complex ecosystems as such rather than modelling techniques that would put limits on risk management exercises related to biodiversity.

The following sections use this theoretical framework to analyze how accounting for the future as a relation between risk and uncertainty is deemed to face such questions of limits. We will see differences at both the ontological and epistemic levels of analysis when it comes to ponder the limits in the substitution of risk for uncertainty. We will show that most theories examining risk and uncertainty do not set limits. Mainstream economics sees neither ontological nor epistemic limit in the substitution of risk for uncertainty. Heterodox international political economy and sociology adopts a critical stance regarding the tools and techniques of mainstream economics for uncertainty reduction. Yet, they see no ontological limit in the range of phenomena likely to be included by a society in order to substitute risk for uncertainty. We discuss a third school of thought as evolutionary political economy, in the wake of how Frank H. Knight (1921) analyzes ontological limits in the substitution of risk for uncertainty. We will see that his analysis of expert judgement to anticipate the future is tantamount to a lack of epistemic limit in the substitution of risk for uncertainty. Finally, the pluralization of science appears as the only way to consider both ontological and epistemic limits in the substitution of risk for uncertainty, as it depends on knowledge production processes that overcome disciplinary boundaries and better include lay and expert knowledge. Table 1 provides a mapping of these approaches according to the theoretical framework presented above. Each cell visualizes whether each of these four approaches considers any limit in the attempt to substitute risk for uncertainty, and if so, whether it privileges an ontological and/or an epistemic understanding of such limits.

Table 1. The limits in the substitution of risk for uncertainty.

	Ontological limits	
Epistemic limits	No	Yes
No	Mainstream economics	Evolutionary political economy
Yes	Heterodox international political economy and sociology	Pluralization of science

Mainstream economics: the sky as the limit

We refer here to mainstream economics as a systematic approach in social sciences linked to fundamental convictions about how markets depend on individual utility maximization, i.e. the maximization of the satisfaction received from consuming a good or service.[3] Mainstream economics sees neither ontological nor epistemic limit in the substitution of risk for uncertainty (see Table 1). It assigns to calculation techniques the power to break down such limits. In predicting future courses of human behavior on earth, mainstream economics aims at transforming an unknown event into a manageable risk thanks to an 'extraordinary faith in quantitative techniques' (Morgan, 1991, p. 1). Such forecasting exercise is made of a mix of expert knowledge and mathematical tools based on the assumption that 'either this world is *not complex*, or it is inhabited by people *with extremely powerful minds and/or computers*' (Dequech, 2004, p. 370, emphasis by the authors). In the wake of the 1913 Nobel Prize for Physics William Thomson (1899), mainstream economics often considers that 'when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind' (p. 73-74). This also includes environmental economics literature developed since the 1970s and the following green growth discourses in their attempt to transform any ecological future into a present economic cost or benefit (Nordhaus, 2015; Pearce et al., 2006).

For mainstream economics, the measurement of utility is the core instrument to reduce uncertainty into numbers. As Moscati (2018, p. 1) points out, 'over the course of the twentieth century, the concept of utility further expanded its reach and became the basis of attempts to analyze the economic decisions of individuals under uncertainty'. The development of the expected-utility theory has indeed aimed at explaining how individuals make rational choices in situation of uncertainty. It is based on the following motto: 'choose the act with the highest expected utility' (Briggs, 2017). While a large strand of expected-utility theory treats uncertainty as subject to an objective and probabilistic calculus of risk, other studies follow the subjective approach pioneered by Friedman and Savage (1948; see also: de Finetti, 1974; Savage, 1972). From this view, a probability is not about the frequency of an event in the real world. As Dequech (2011, p. 625) points out, it is about 'a property of the way one thinks about the world'. Probabilities here derive from individual preferences. Be it subjective or objective, however, the risk is defined by a probability calculus that transforms uncertainty into a set of numbers. There is no ontological neither epistemic limit in the substitution of risk for uncertainty. And it is worth noting that such a way to calculate and anticipate policy preferences is not restricted to economics. It also feeds much debates in political science and environmental governance. The well-known 'tragedy of the commons' might indeed be solved by what Cashore and Bernstein (2019) call the 'optimization school', which treats 'as objective the subjective belief that environmental issues matter more if they can be converted into economic [and thus quantitative] values' (p. 11).

These quantitative techniques do not come out of nowhere. They rely on expert knowledge. Mainstream economics developed various methods to identify the best knowledge likely to ponder collective expert judgements. This includes 'triangulation

strategies' to combine different methodologies in the exploration of a single phenomenon (Denzin, 1978, p. 291; Jick, 1979), the 'Delphi method' used to develop an opinion consensus from expert-driven questionnaires (Dalkey & Helmer, 1963, p. 458), or the 'rational consensus' developed by Cooke (1991, p. 81) to reach expert opinion in science. All these techniques build on mathematical procedures and models to weight experts judgement, such as 'long records (statistics) of experts' past performances' (Boumans, 2015, p. 177). Here, mainstream economics focuses in particular on the absence of epistemic limit in the capacity of experts and their theories to produce the tools and techniques to anticipate the future.

The same techniques are used by environmental economics, which also finds ways to reduce nature-based uncertainty by measuring it. Biodiversity, ecosystem services or greenhouse gases are all viewed as commensurable according to a price unit, what MacKenzie (2009) describes as 'making things the same'. Since the pioneer study of Costanza et al. (1997) that valued ecosystems at 33 trillions of US dollars of annual services to human beings, the growing importance of research on ecosystem services valuation led to the following leitmotiv in environmental studies: 'we don't protect what we don't value' (Myers & Reichert, 1997). This can be rephrased as 'we don't protect what we don't economically know'. The various methods to value nature in monetary terms are inspired by utility-based models, such as contingent valuation methods based on survey, in which individuals are asked about their preferences for environmental goods or services. As Skidelsky (2019) points out, these methods give economics 'a unique predictive power, especially as the utilities can all be expressed and manipulated quantitatively'. They homogenize the heterogeneity of nature on a quantitative basis and reduce ecological uncertainty in setting economic values.

The way mainstream economics conceives nature requires to put a value in the present on costs and benefits occurring in the future. In economic jargon, this is what discounting the future means. At the microeconomic level, this supposes setting a discount rate accounting for the degree to which we prefer present benefits (for instance money today) over future benefits (money in the future), what is commonly known as 'revealed time preference'. At the macroeconomic level, the discount rate sets the same type of preference, yet at the level of a defined community (Baumstark et al., 2005). Such uncertainty reduction in mainstream and environmental economics has been popularized since 2018 as William Nordhaus was awarded the Nobel Memorial Prize in Economic Sciences for his work on calculations techniques to estimate how much the present generation should invest in limiting climate change (Nordhaus, 2015). These discounting models are however often wrong and contested (Hickel, 2018; Keen, 2020), and built on previous assumptions and beliefs. One of the most contentious issue is that environmental economists generally use a positive figure – and a pretty high positive figure for Nordhaus – in their valuation of the present with regard to the future.[4] This deters investment to quickly reduce our environmental impacts, as its costs would be much higher today than in the future.

In brief, mainstream economics sees neither ontological nor epistemic limit in the ability of probability calculus, expertise and mathematical modelling to substitute risk for uncertainty. As Reddy points out (1996, p. 230), this may even explain why mainstream economic scholars so often do not make any distinction between the terms risk and uncertainty – a remark which according to Blyth (2006) is also

valid for political scientists who 'routinely confuse risk and uncertainty' (p. 495). While this drives most debates in environmental governance, other approaches identified as distant from mainstream economics are also at pain in considering limits in the substitution of risk for uncertainty, whether ontologically or epistemically.

Heterodox international political economy and sociology: the how and the why of mastering the future

We examine here heterodox approaches on risk and uncertainty in international political economy and sociology. While we are well aware that heterodox is a category encompassing many different traditions, we take here a broad understanding that goes back to early debates surrounding the development of the field of international political economy: heterodox scholars at least share a recognition of the subjectivity of social sciences in the wake of a post-positivist epistemology and of what Murphy and Tooze (1991, p. 6) consider as the 'variety of forms of historical and social explanations' (see also the editorial of the first issue of RIPE: Amin et al., 1994). Theories discussed here all question the lack of epistemic limits presumed by mainstream economics in substituting risk for uncertainty. Few of them, however, see ontological limits in the range of phenomena likely to be subject to questionable methods of uncertainty reduction (see Table 1).

Arguably, the most abstract way these studies understand how capitalism responds to an uncertain future is based on what Beckert (2016) calls 'imagined futures'. Anderson (2010) also identified imagination as one among other practices of anticipation, in which 'future events, states of affairs, or persons are imagined "as if" they were actual or real' (p. 785). German social theory is probably the most forward-looking on the concept of risk from this perspective. While Beckert recently explored the impact of imagined futures on the dynamics of capitalism – what is called the 'sociology of expectations' –, Luhmann's 'system theory' (1986) also includes significant developments on the construction of risks and threats. Social systems are viewed as having increasingly internalized complex external threats as risks to be dealt with systematically – this is what Luhmann (2013, p. 78) calls the 'security of expectation'. However, complexity theory just as complexity reduction always produces another layer of uncertainty. Beck (1986) drew on Luhmann to develop his analysis of risk society, which in a way just deals with this puzzle. If science is no longer synonymous of security and progress, it keeps producing the problems it was supposed to solve. This also prompts a shift in authority from governments to researchers and global firms in charge of ever developing new tools and techniques to reduce uncertainty. Beck (2006) extended his argument to argue that risk has become the defining feature of late modernity, since 'modern society has become a risk society in the sense that it is increasingly occupied with debating, preventing and managing risks that it itself has produced' (p. 332). His definition of risk emphasizes the importance of time, reversing 'the relationship of past, present and future' (2000, p. 214). Thus, the present is based on the past to build future risks. However, it is worth noting that Beck never really distinguishes between risk and uncertainty. Aradau and von Munster (2012) point out that Beck confuses risk and uncertainty, leaving the latter aside, since 'uncertainty is merely the residual of risk, the incalculable leftover of risk

management' (p. 21).[5] Like Luhmann, Beck thus sees epistemic, but no ontological limit in the substitution of risk for uncertainty as the production of another layer of uncertainty relies on previous substitutions of risk for uncertainty. Against this background, imagination, security of expectation or the embodiment of risk within society all allow to overcome the ontological limit in substituting risk for uncertainty.

Another strand of scholarship adopts a lower level of abstraction by considering that imagination is embedded in the real world through social conventions. Orléan (1987) recognizes the radical uncertainty of economic and market relations, but still finds ways to anticipate the future thanks to social conventions such as mimetic behaviors: 'when an individual has no criteria to discriminate between two opinions, rationality requires him to imitate a third party' (p. 163; our translation). Similarly, Chiapello (2015) provides a critical analysis of the financialization of valuation as a specific form of calculation. Here again, she explains how such mechanism is made possible through 'conventions used in order to pluralize the idea of economic quantification or monetary measurement' (p. 14) Another good case in point regarding the anticipatory power of such conventions is provided by Nelson and Katzestein's (2013) analysis of the 2008 financial crisis. In their view, finance lies in the world of uncertainty rather than risk, as economics, calculative practices and standards cannot foresee disasters. However, they argue that actors can still rely on social conventions to take their decisions, thus substituting risk for uncertainty. Katzenstein's further research with Seybert (2018) suggests that such ability to face an uncertain future brings into play a 'protean power', which 'results from the improvisations and innovations of agile actors and processes of the actualization of potentialities […] coping with uncertainty' (p. 6). However, these conventions are not universal. They must be considered in their specific social context. It is worth to remind here Fourcade's (2011) prominent study on claims to compensation from damages resulting from large oil spills in the United States and in Europe. She explains not just how 'something that stands normally outside market exchange comes to be attributed an economic (monetary) value' (p. 1723); she also shows how such monetization of nature significantly differs according to distinct sociocultural environments on both sides of the Atlantic. Ultimately, conventions brought into play by different kinds of actors all allow to overcome the ontological limit in substituting risk for uncertainty.

Another strand of scholarship criticizing the lack of epistemic limits builds on Foucault to consider risk as a particular instrument of governmentality. It examines the performativity of discourses related to risk and the intrinsic dialectics between power and knowledge regarding the governance of the future. For instance, with a particular focus on the role of insurance as securing so-called 'liberal forms of life', Lobo-Guerrero (2014) emphasizes the importance of the 'strategisation of time', an abstraction process which 'projects into a future the technological reality of the model fabricating the uncertainties of their own scheme' (p. 366). From his point of view, knowledge on temporality allows for pushing 'the limits of insurability' (p. 356), and with it the limits of anticipation by the production of predictive models. In the same vein, Ericson et al. (2003) see uncertainty as an object of governance insofar as 'private insurance has come to constitute a vast behind-the-scenes system of informal governance' (p. 226). Many other scholars have written about risk as a technology of power and government to improve crime prevention

(O'Malley, 1992, 2003, 2008), to settle down the welfare state (Ewald, 1986, 1996), to govern environmental (Gouldson & Bebbington, 2007) or terrorism risk (Aradau & van Munster, 2007), and eventually to manage everything (Power, 2004). From such Foucault-inspired approaches, all risks are likely to be governed and ultimately anticipated – so that there is no ontological limit in the substitution of risk for uncertainty.

To sum up, similar analytical approaches are applied across many studies in heterodox international political economy and sociology to question the practices and underlying theories that assume no epistemic limit in the ability to reduce uncertainty in such a way as to make it an objectified, quantified and valuable risk. Few studies, however, see an ontological limit in the range of phenomena likely to be subject to such substitution of risk for uncertainty. To find such limit, we turn now to evolutionary political economy approaches. As we will see below, this will help us questioning the claim made by a large body of economic analysis to have the proper tools to transform any uncertain phenomenon into a set of quantitative risks.

Evolutionary political economy: the power of Knightian expert judgement in the face of true uncertainty

Evolutionary approaches presume that scientific knowledge aims at providing explanations on the origins, developments and transformations of individuals and institutions. They put great emphasis on processes and innovation, complex systems, and especially institutional dynamics (Dopfer, 2006; Hanappi & Scholz-Wäckerle, 2017). Two key thinkers stand out when it comes to dealing with the institutional dynamics that gears the political economy of uncertainty: John Maynard Keynes and Frank H. Knight. Both published in 1921 a book that will be celebrated for the next century.[6] While Keynes' *Treatise on Probabilities* (1921) explored the links between calculability and the production of knowledge, Knight's *Risk, Uncertainty and Profit* (1921) forged new avenues for analyzing the relations between risk and uncertainty. Keynes conceives cases of 'radical' uncertainty and Knight of 'true' uncertainty. Both make a clear distinction between risk and uncertainty and find ways to reduce part of this unknown. However, only Knight sets a clear ontological limit in the attempt to substitute risk for uncertainty.

As pointed out by Shackle (1967), another key figure in evolutionary political economy, 'uncertainty was the new strand placed gleamingly in the skein of economic ideas in the 1930s' (p. 6). Keynes provided a simple definition of uncertainty in a famous article published in the *Quarterly Journal of Economics*: 'a matter for which there is no scientific basis on which to form any calculable probability whatever. We simply do not know' (1937, pp. 213–214).[7] Best underlines that both Knight and Keynes 'saw economic decision making as based on conventional rather than perfectly rational thinking' (p. 364). Keynes' solution to face radical uncertainty is indeed based on the role played by social conventions in the 'intersubjective nature of economic activity' (Best, 2008, p. 364).[8] In contrast, Knight distinguishes between three situations – risk, uncertainty, and true uncertainty – that not only gives us a detailed spectrum of the different forms of risk and uncertainty, but also attributes to knowledge the ability to overcome situations of so-called true uncertainty. With an emphasis on expert judgement, he sees no

epistemic limit in the ability to face such situations (see Table 1). However, as we will see below, Knight identifies a strong ontological limit in the ability of anticipating the future when this resembles situations of true uncertainty.

In *Risk, Uncertainty and Profit*, Knight (1921) explores how profit is generated in different situations of 'partial knowledge' (p. 199), developing various categories to secure 'better knowledge of and control over the future' (p. 260). These categories are represented in his well-known triptych: a priori probability, statistical probability and estimates of probability. A priori probability is used in a situation of entire rationality close to laboratory conditions, in which alternatives are homogeneously classified. However, he points out that we hardly find in practice really homogeneous classifications 'in the sense in which mathematical probability implies, as in the case of successive throws of a perfect die' (p. 246). For its part, statistical probability aims at objectifying a more uncertain situation, yet still considered by Knight to be a risk. It differs from a priori probability according to 'the accuracy of classification of the instances grouped together' (p. 217), i.e. heterogeneity versus homogeneity. Indeed, statistical probability can only be computed empirically, and not, as a priori probability, on general principles (p. 224). The next level of this triptych – estimates of probability – is an uncertainty, in which there is 'no valid basis of any kind for classifying instances' (p. 225). Yet, according to Knight, such situations can still be managed and transformed into statistical probabilities with the help of estimates of probability. It requires estimating 'the given factors in a situation and also estimate the probability that any particular consequence will follow from any of them if present in the degree assumed' (p. 214). Therefore, uncertainty describes situations in which complexity is still out of our frame of reference. Transforming undefined uncertainty into manageable risk then depends on quantitative tools and categorizations.

The core of the analysis driving towards an ontological limit lies in the difference that Knight draws between uncertainty and true uncertainty: 'that higher form of uncertainty not susceptible to measurement and hence to elimination' (p. 232). The entrepreneur, according to Knight, often deals with such situations of true uncertainty that call off quantitative reasoning and require 'judgment', 'common sense', or 'intuition' (p. 211). Knight thus sets an ontological limit in the substitution of risk for uncertainty, while recognizing the ability of expert judgment to reduce at least part of it. Against this background, he distinguishes between individuals facing true uncertainty and those having the skills to predict better than others (p. 241). In a nutshell, Knight considers that the future cannot always be dealt quantitatively, but that expert judgement can compensate for that. He sees such knowledge in the hands of smart entrepreneurs and consultants, thus able to overcome the epistemic limit to substitute risk for uncertainty.[9]

Pluralization of science: earth as the limit

We have seen so far that most theories examining risk and uncertainty see no ontological and/or epistemic limit in the substitution of risk for uncertainty. We now probe our second argument according to which both the ontological and epistemic limits exist in the substitution of risk for uncertainty (see Table 1). This second argument draws on the assumption that accounting for the uncertainty of the future depends on what we call here a pluralization of science, which describes

knowledge production processes aimed at overcoming disciplinary boundaries and better including lay and expert knowledge.

We are not short of studies that point out the co-production of science and society, while acknowledging the power of expertise as a mean of control over the material world (Jasanoff, 2004; Latour, 1993; Pestre, 2013). As Jasanoff suggests (2004, p. 3), scientific knowledge is embedded in 'social practices, identities, norms, conventions, discourses, instruments and institutions'. Under the apparent technicality of the subject and the neutrality of science, decisions of experts escape democratic debate although they engage our common future. In the same vein, Latour (2017) recently underlined in the context of the twin globalization and ecological crisis the importance of '*multiplying* points of view (…) taking into account a greater number of beings, cultures, phenomena, organisms and people' (p. 23, our translation). Callon et al. (2001, p. 36) view in 'hybrid fora' a device to address scientific controversies in exploratory spaces open to heterogonous groups, knowledge and experiences. These hybrid fora challenge both knowledge production captured by experts, as well as scientific representation captured by elected politicians. Graz and Hauert (2019) developed the concept of 'pluralization of knowledge' that reflects such a need 'to reach out to a broader pool on an ad-hoc basis' in order to 'look for cognitive resources on a much more heterogeneous basis' (pp. 15–16). In contrast to Callon and his co-authors focused on regime of controversies, they provide 'insights for an in-depth understanding of the co-production of socio-technical knowledge' (Graz & Hauert, 2019, p. 10). In the following analysis, we draw from these accounts to examine how the pluralization of science is a promising avenue to cope with limits in substituting risk for uncertainty at both ontological and epistemic levels of analysis. We start with the need to overcome boundaries of disciplinary knowledge and follow with the need to better include lay and expert knowledge.

The first aspect of pluralization of science relates to interdisciplinarity. According to Miller (2010, p. 1), knowledge production has become 'less effective due to disciplinary fragmentation'. Similarly, Epstein (2019) underlines the disadvantages of specialization in addressing wicked environment problems where not all information is available to make a decision. This mostly reflects a lack of interdisciplinarity related to the outcome of individual skills in different fields. However, a pluralization of science depends on a form of interdisciplinarity that also relies on the various experiences of a broader range of stakeholders. From this view, it is mainly a collective process. It is in this context for instance that Cashore and Bernstein (2019) are calling for a scholarly 'Marshal Plan' that would include many fields of critical social sciences. They underline that such a collaboration would be of particular help to address the challenges posed by climate change and ongoing massive species extinctions (p. 1). The Delphi method discussed above had similar inputs regarding interdisciplinarity and collective decision-making, by indicating that 'several heads are better than one in making subjective conjectures about the future' (Weaver, 1971, p. 268). Yet, this method still recognizes the superior role of specialized knowledge seen as able to 'make conjectures based upon rational judgement rather than merely guessing' (p. 268). It is worth noting that Haas (2017) – well known for his concept of epistemic communities – still considers today that the knowledge produced within the confines of a discipline bears the highest expectations: 'panels with expertise based on disciplinary

credentials proved more influential than those with more open-ended experts from civil society' (p. 62).

In addition to embracing many disciplinary fields, a pluralization of science also builds on the ability to better connect lay and expert knowledge. In this sense, it reflects a form of civic science, which Bäckstrand (2003, p. 25) describes as 'enhancing public understanding of science, increasing citizen participation, diversifying representation in, and promoting democratization of science'. A good case in point regarding such pluralization is the study of Funtowicz and Ravetz (1994) on the democratization of knowledge required for a proper understanding of songbirds' contribution to nature – what they call a 'postnormal science'. Such postnormal science requires more than one discipline in the analysis of a complex phenomenon, and the extension of the knowledge production process to lay actors concerned by the issue at stake. From a different perspective, de Sousa Santos (2018) recently made a comprehensive critique of the 'epistemologies of the North' valuing expert and scientific knowledge and emphasized the need for a shift towards 'epistemologies of the South' valuing plural knowledge based on a move from 'knowing-about' to 'knowing-with'.

As a way of illustration in the field of global environmental governance, we can draw on a growing number of international initiatives and platforms that aim at including such diversity of knowledge within their knowledge production processes. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is a good case in point.[10] The IPBES recently claimed to include a larger range of actors for efficient biodiversity and ecosystem services assessment and related valuation (Dunkley et al., 2018; Vadrot, 2014). Its reports recognize both the diversity of nature's values on the one hand – including non-quantitative forms of valuation – and the plurality of forms of knowledge on the other – including 'governments, civil society organizations, and indigenous people and local communities' (IPBES, 2018, p. 30). Yet, a gap remains between the discourse (or even the will), and the practice of including a more heterogenous basis of knowledge into mainstream science. This concerns both the question of interdisciplinarity and the ability to take indigenous and local knowledge aboard (Hughes & Vadrot, 2019); it also applies for the politics of natural disasters and the involvement and production of knowledge of the United Nations Office for Disaster Risk Reduction (UNISDR) (Revet, 2018). Studies point out that the IPBES failed 'to find ways of dealing with contrasting rationalists, diverging ontologies and different criteria for knowledge validation' (Dunkley et al., 2018, p. 794). Brand and Vadrot (2013) draw on the concept of epistemic selectivity to explain such a phenomenon of 'knowledge–power nexus' where political institutions privilege particular forms of knowledge over others. From such perspective, some consider that the IPBES needs 'to open up procedures and practices of participation and inclusion in order to accommodate pluralism, contestation and incommensurable perspectives and knowledge systems' (Díaz-Reviriego et al., 2019, p. 457). For instance, while the United States advocated a so-called science-driven process focused on ecosystem services, valuation and quantification; Bolivia was firmly opposed to 'the ecosystem framing and sought greater plurality of worldviews represented' (Hughes & Vadrot, 2019, p. 30). In the domain of climate diplomacy, Belfer et al. (2019) and colleagues also showed that the actual involvement of indigenous peoples remained limited. Ultimately, such a difficulty of combining different and sometimes incommensurable

modes of knowledge also relates to actors' different understandings of risk and uncertainty, which may subsequently shape their policy preferences.

Finally, a pluralization of science that emphasizes both ontological and epistemic limits in substituting risk for uncertainty sheds light on the incompleteness of knowledge. We just do not know whether all the necessary knowledge is included, beat across existing scientific disciplines or across lay and expert knowledge. Overall, many challenges remain regarding a proper pluralization of science, as well as a recognition of the ontological and epistemic limits in the substitution of risk for uncertainty.

Conclusion

In a context of global, epochal and complex changes, this article has examined the ability to anticipate an uncertain future, with insights from global environmental governance and opposing responses to the relations between the economy, nature and society. It contends that a distinction must be made between risk and uncertainty, as well as between ontological and epistemic levels of analysis, and therefore set or not set ontological and/or epistemic limits in substituting risk for uncertainty. From this assumption, the analysis has shown, first, that most theories see no ontological and/or epistemic limit in the substitution of risk for uncertainty; second, that the pluralization of science is a more promising avenue to cope with limits in substituting risk for uncertainty. Mainstream economics sees neither ontological nor epistemic limit in substituting risk for uncertainty. Studies in heterodox international political economy and sociology, for their part, question such lack of epistemic limits, while reproducing somehow a 'no limit ontology' in the range of phenomena subject to their critique. We have furthermore drawn on Knight's concept of true uncertainty to suggest that, from an evolutionary political economy perspective, there are ontological limits in the substitution of risk for uncertainty. Yet, such an approach confers on expert judgement the ability to overcome the epistemic limit. The pluralization of science shows that accounting for the uncertainty of the future depends on knowledge production processes better able to overcome disciplinary boundaries and include lay and expert knowledge. However, many challenges remain for a proper application of a pluralization of science, one of them being the hegemony of a particular form of knowledge over others. Therefore, this article suggests that international political economy scholars would be well informed to consider the question of limits as well as the nature of such limits when analyzing how uncertainty is reduced.

This ultimately leads to take the question of the incompleteness of knowledge seriously, as both our individual and collective capacities to anticipate the future by substituting risk for uncertainty are limited. A first avenue for future research concerns the burgeoning studies on resilience. This question of limits may clarify existing debates on the use of the concept of resilience to appraise the ability of societies to face unexpected events and on how such policies are likely to take power issues onboard. While some scholars take a critical stance on the overall relevance of the concept viewed as a product of contemporary neoliberalism (Bourbeau, 2018; Felli, 2016; Phelan et al., 2013; Walker & Cooper, 2011), others argue that it provides interesting insights to reflect on our limits to anticipate the future. According to Holling (1973), a pioneer on ecological resilience, this may

even be close to what we describe here as pluralization of science: a resilience approach 'would emphasize the need to keep options open, (…) heterogeneity [and] the recognition of our ignorance' (p. 21).

A second course of future analysis relates to research undertaken under the umbrella of future studies – particularly relevant when analyzing the knowledge used to govern environmental futures (Granjou et al., 2017). For instance, scholarship on anticipatory action and governance underlines the political and contested nature of uncertainty reduction strategies, albeit without explicitly distinguishing between ontological and epistemic dimensions, let alone the existence of intrinsic limits in such exercises (Aykut et al., 2019; Guston, 2014). Similarly, Anderson (2010) deconstructs the styles, practices and logics through which the future is disclosed, yet without taking into account the ontological limits that face what he sees as a proliferation of anticipatory action. Engaging the resilience and anticipatory action and governance literature could help specifying how such policies are justified, legitimized, and contested beyond grand narratives.

Finally, there is ample space for generalizing the argument made on the pluralization of science. A thorny question in this regard is the limits that the advocates of 'citizens science' could face in the demand to further extend the scope of what we call here the pluralization of science (Irwin, 1995; McKinley et al., 2017). Moreover, globalizing the pluralization of science brings to mind the decolonial turn in international relations (Mantz, 2019; Seth, 2011). Yet, it also raises broader and, arguably, more urgent concerns, as it is less a matter of disciplinary identity than how to face the global ecological crisis within the constraints of a just transition (Morena et al., 2019). This question is particularly urgent in the context of the Covid-19 crisis and its both global and local socioeconomic and political consequences. International political economy scholars have here a fertile ground for research on how unexpected events are disrupting the present and creating the future – while taking into account the question of limits when analyzing how the future may be anticipated. Arguably, exiting such crises cannot be done without better linking up with the 'degrowth movement'. Indeed, degrowth first calls for a greater democratization of decision-making processes as it applies a pluralization of science for many other teleological positions and other utopias than environmental sustainability, such as issues of class, race and gender (Parrique, 2020). In addition, degrowth makes particular emphasis on the question of limits, and as Kallis (2019, p. 1) recently underlined, 'Western culture is infatuated with the dream of overcoming limits'.

Notes

1. We are well aware that theories discussed in this article do not exhaust accounts on risk and uncertainty in social sciences. They only account for what we see as the most relevant interdisciplinary and pluralist corpus for the puzzle of risk and uncertainty in IPE debates.
2. Insurance losses from natural disasters were estimated at 219 billions of US dollars between 2017 and 2018, 'the highest-ever for a two-year period' (Swiss Re Institute, 2019).
3. We are aware that the distinction between mainstream and heterodox has fed much debates without necessary much clarity about the criteria defining one or the other (Jo et al., 2018). It includes at its core neoclassical orthodoxy, but also extends to

behavioral economics and with some variations, a number of other schools of thought (for further details, see: Dobusch & Kapeller, 2012).

4. Costanza and his colleagues who did the first global monetary assessment of nature's value used a discount rate of 5% in order to convert stock values into annual flows. Such a rate of conversion was crucial to reach the final figure of 33 trillion of US dollars for the annual services provided by ecosystems for human beings. This is slightly more than Nordhaus' average 4.3% used in his modelling, and clearly more than Stern (2006) in his review of the economics of climate change, using a discount rate of 1%.
5. In the same vein, Ericson (2005, p. 660) points out that 'Beck should have called it the uncertain society because his focus is on potential and actual scientific and technological disasters that have proven unpredictable and entail immeasurable human suffering'.
6. See the forthcoming special issue of the *Cambridge Journal of Economics* provisionally entitled 'Keynes' *Treatise on Probability* and Knight's *Risk, Uncertainty, and Profit* After 100 Years' (Editors: Phil Faulkner, Alberto Feduzi, C.R. McCann, Jr, Jochen Runde).
7. The whole quote is the following: 'By "uncertain" knowledge […] I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which 1am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealth-owners in the social system in 1970. About these matters, there is no scientific basis on which to form any calculable probability whatever. We simply do not know" (J. M. Keynes, 1937, pp. 213–214).
8. To some degree, he could even be related to the heterodox approaches in international political economy and sociology seen above, since no ontological limits seem likely to arise in such transformation of uncertainty into risk.
9. John R. Commons' concept of 'futurity' would also deserve further analysis in the wake of his observations that 'man lives in the future but acts in the present' (1934, p. 58). Basically, Commons sees no epistemic limit if rights – or 'the collective working rules of society' – are properly negotiated between the parties concerned to provide a 'security of expectation'. The recent best-seller co-authored by Mervyn King, former Governor of the Bank of England, reaches somehow similar conclusions in considering that eventually creative business, political and personal strategies are better than number to cope with radical uncertainty (Kay & King, 2020).
10. The official aim of the IPBES is to provide Governments, the private sector, and civil society with scientifically credible and independent up-to-date assessments of available knowledge to make informed decisions at the local, regional and international levels.

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